MONTANE INSULAR BUTTERFLY BIOGEOGRAPHY: FAUNA OF BALL MOUNTAIN, SISKIYOU COUNTY, CALIFORNIA

Arthur M. Shapiro[1]

ABSTRACT.—Ball Mountain is an isolated, mostly heavily forested peak reaching the subalpine zone (2,330 m) in eastern Siskiyou County north of Mt. Shasta, California. It supports a rich fauna of at least 68 butterfly species showing affinities to the faunas of the Trinity Alps and Eddies, the Warners, and the Cascades. Rare or endemic entities include *Speyeria mormonia*, *Lycaena heteronea gravenotata*, and melanic forms of *Speyeria atlantis* and *Agriades "glandon."* Several zones of intergradation or hybridization impinge on the fauna as well.

Both the physical and biotic geography of northern California are very complex. The jumbled terrain of the Klamath-Trinity-Siskiyou upland and the volcanic southern Cascades provides rapid climatic gradients that are reflected in the plant communities of the region. Most of these communities are still inadequately characterized, and several important areas are poorly known even from a floristic standpoint. The butterfly faunas of northern California were extremely poorly documented prior to the 1970s, with only one major paper (Williams 1909) and scattered specimens in museums, often inadequately labeled. From 1976 through 1980 a major effort was mounted to document the butterfly fauna of the Trinity Alps and the Eddies (Shapiro, Palm, and Wcislo 1981) in the hope of using these faunas to test some historical scenarios advanced by botanists to account for the origins of the subalpine and alpine biota of the Sierra Nevada range. Although no definitive tests of those scenarios emerged, this study uncovered so much unanticipated complexity (along with anticipated Klamath endemism) in the Trinity-Eddy faunas that it has been continued at several sites which, by virtue of unique location, topography, or vegetation seemed most likely to provide important information on the biogeographic history of the northern California butterfly faunas. An especially rewarding site is Ball Mountain, Siskiyou County.

Ball Mountain is one of only three peaks between Mount Shasta and the Oregon border, east of U.S. Highway 5, to reach above 2,270 m. The highest of them, Goosenest, at 2,812 m, is a recent Cascade volcano with a poorly vegetated lava cone, though it does have some rare alpine plants (e.g., *Hulsea nana* Gray, Compositae, which it shares with two other recent volcanoes, Mts. Lassen and Shasta, and with the nonvolcanic Mt. Eddy). The other two, Willow Creek Mountain (2,676 m) and Ball Mountain, (2,330 m), are only 8 km apart and share a common base and access by road. Both are older, Pliocene volcanoes, mostly basaltic (Ball) or andesitic (Willow Creek). Ball Mountain has two old vents marked by pyroclastic jumbles; the higher of these bears a fire watchtower. There is no evidence of recent (Holocene) volcanic impact on the vegetation of the mountain, which has presumably evolved to its present state through the Pleistocene and thereafter. Ball Mountain and Willow Creek Mountain rise fairly gradually from a rolling volcanic upland, the Little Shasta country, to the west (largely Tertiary flows, with altitudes from 750–1,200 m); Ball Mountain, the more easterly, drops off abruptly to the Quaternary lake-bed alluvial plain near Macdoel, ca 1,275 m (Fig. 1).

Although Willow Creek Mountain is the higher of the two, it is more continuously forested and has a smaller variety of habitats and less access by road than Ball Mountain. Access to both is provided by USFS road 47NO3, the extension of York Road, which near Lodgepole Station turns northeastward, whereas road 46N11 goes due south to Willow Creek Mountain and 46N10 goes along the flank of Ball Mountain, looping around Little

[1]Department of Zoology, University of California, Davis, California 95616.

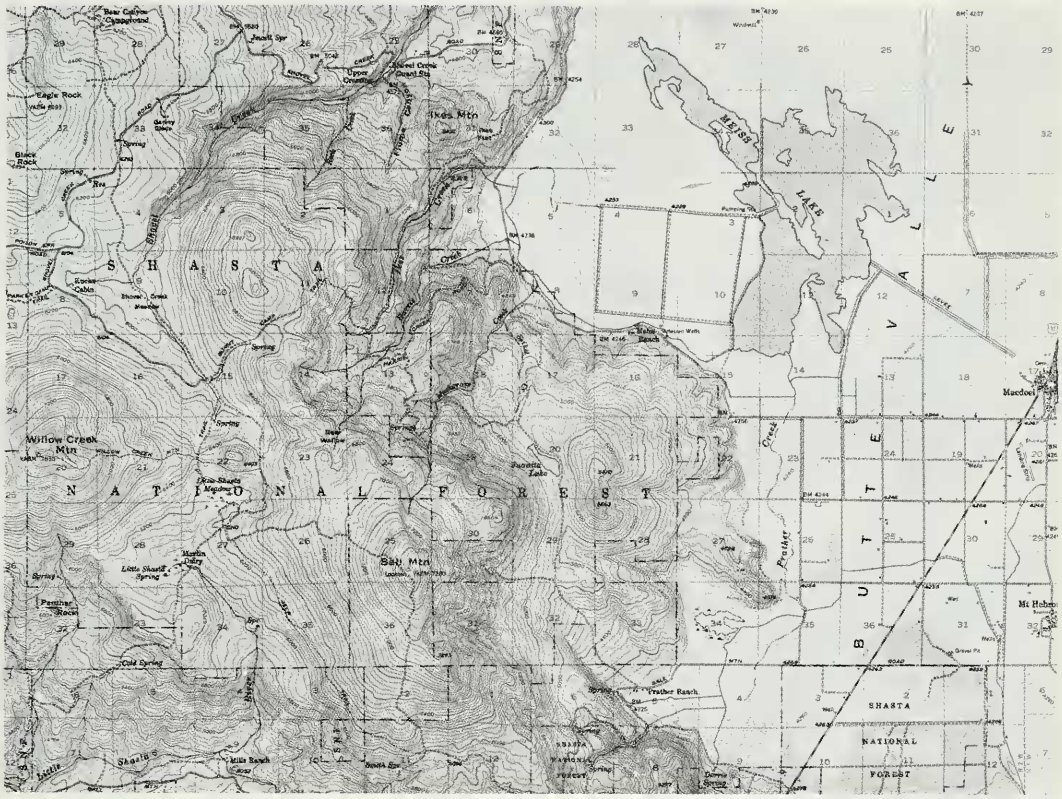

Fig. 1. Detail of Ball Mountain area from USGS 15′ topographic series, Macdoel quadrangle, 1954. Contour interval 40 feet (12.1 m).

Shasta Meadow and Martin Dairy Campground as 46N09; another spur leads to the lookout. Access for hikers and heavy-duty vehicles is also possible from Ball Mountain Road (unnumbered), which is paved beyond Table Rock (1,130 m) but becomes nearly impassable to most vehicles thereafter. This road joins the USFS roads south of Martin Dairy. The entire area is mapped on the USFS map of the Klamath National Forest, Goosenest Ranger District. The best detail is on the 1968 version. The Ball Mountain lookout is R6.E, T45.N. The entire area reported on in this paper can be collected comfortably by two people in one day, or by one person in two days, with a vehicle.

VEGETATION

The vegetation of Ball Mountain is apparently undescribed in the botanical or forestry literature. Like many mountains in northern California, it provides a "telescoped" sequence of Merriam's "Life Zones," such that one may drive from "Upper Sonoran" to "Subalpine" in less than 20 km (this very short linear distance facilitates altitudinal migration of valley and foothill butterflies to the high montane meadows).

The general zonation of forest vegetation on Ball Mountain and the platform on which it sits more or less corresponds to the outline provided by Rundel, Parsons, and Gordon (1977) for the California portion of the Cascades. The lowest elevations, representing an extension of the Little Shasta country, have an open woodland dominated by shrubby forms of Oregon Oak (*Quercus garryana* Dougl.), with juniper (*Juniperus occidentalis* ssp. *occidentalis* Hook., near its southwestern limit) as an associate. This is quickly replaced by a mixed conifer association beginning at just over 900 m, dominated by yellow pine (*Pinus ponderosa* Laws.), with incense cedar (*Calo-*

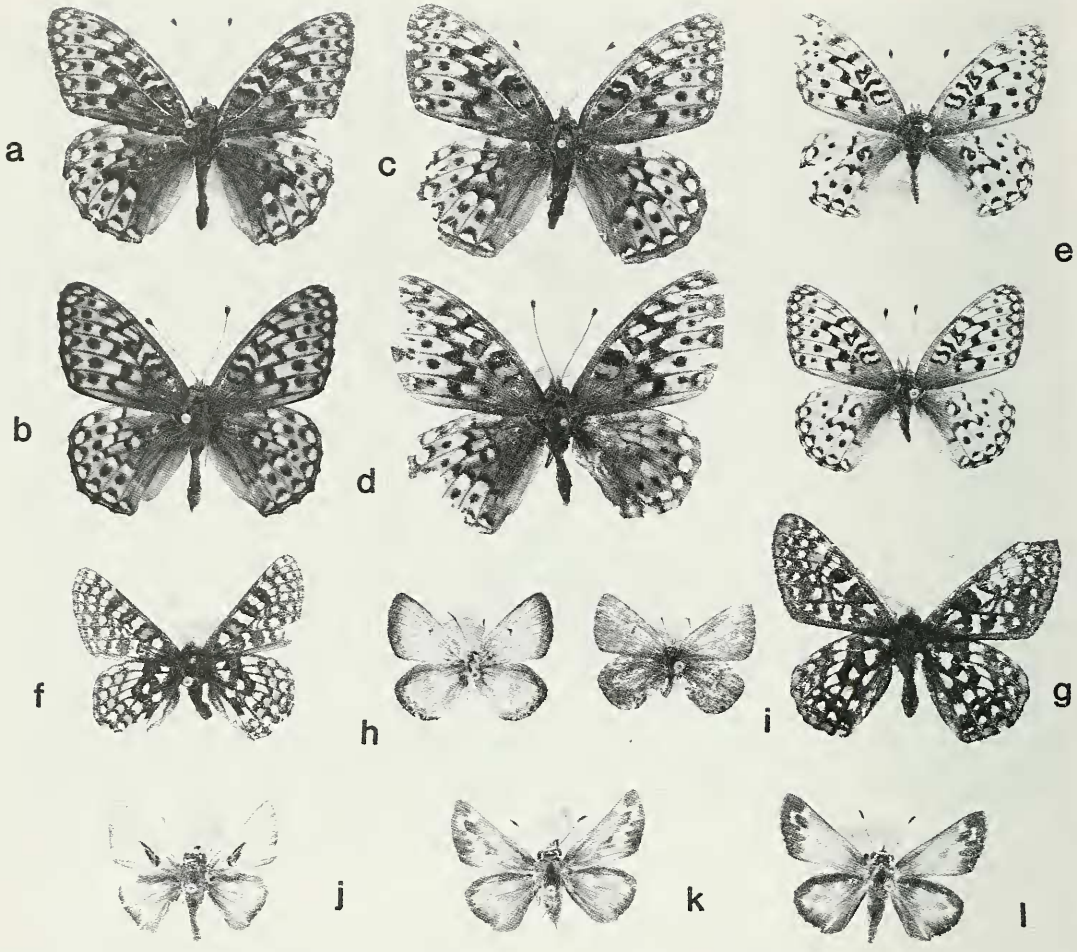

Fig. 2. Rare butterflies from Ball Mountain, dorsal surfaces: a, *Speyeria atlantis* (melanic form), male, viii.10.83; b, same (normal form), male, vii.3.85; c, same (melanic form), female, viii.10.83; d, same (melanic form), female aberration, ix.5.85; e, *Speyeria mormonia*, 2 females, ix.5.85; f, *Euphydryas editha*, male, vi.12.85; g, *Euphydryas chalcedona*, male, vi.12.85; h, *Agriades "glandon,"* male, vii.3.85; i, same, female, vii.3.85; j, *Hesperia harpalus*, male, ix.5.85; k, same, light female, ix.5.85; l, same, dark female, ix.5.85.

cedrus decurrens Torr.) and white fir (*Abies concolor* Lindl.) locally abundant. At about 1,450 m lodgepole pine (*Pinus contorta* ssp. *murrayana* Grev. & Balf.) first appears in cold and poor sites and quickly becomes dominant; above 1,650 m it is joined by Red Fir (*Abies magnifica* var. *shastensis* Lemm.) and western white pine (*Pinus monticola* Dougl.), and this association continues nearly to the summit. Within it are extensive sedgy and grassy meadows ranging from dry to wet and rimmed by quaking aspen (*Populus tremuloides* Michx.), many of which are uncharacteristically large for the species. These are among the most diverse sites for both herbs and butterflies. The area surrounding both summits supports a virtually pure stand of whitebark pine (*Pinus albicaulis* Engelm.). This subalpine forest is characteristically open, with many herbs and shrubs in the understory; the shrubs, which include sagebrush (*Artemisia tridentata* Nutt.) and *Haplopappus bloomeri* Gray, predominate among the pyroclasts, whereas herbaceous perennials (*Monardella odoratissima* ssp. *pallida* Epl., *Eriogonum umbellatum* Torr., etc.) cover the light, sandy soils elsewhere.

Understory vegetation in the montane conifer forests is extremely undiverse, with extensive areas dominated by pine-mat manzanita (*Arctostaphylos nevadensis* Gray) in successional sites. The greatest herbaceous

TABLE 1. Occurrence of species on Ball Mountain on collecting dates, 1983 and 1985.

	vi.12.85	vii.3.85	vii.15.83	viii.10.83	viii.10.85	ix.5.85	ix.7.83
Papilio zelicaon Lucas	x	x			x		
Papilio rutulus Lucas	x	x					
Papilio eurymedon Lucas		x					
Parnassius clodius Men. ssp.	x	x					
Neophasia menapia Feld. & Feld.					x	x	x
Pontia beckerii Edw.			x		x	x	
Pontia occidentalis Reak.	x	x	x	x	x	x	x
Pieris napi L. ssp.	x						
Pieris rapae L.	x				x	x	
Colias eurytheme Bdv.	x	x	x	x	x	x	x
Colias philodice eriphyle Edw.	x	x	x	x	x	x	
Colias eurytheme X *philodice*	x	x	x	x	x	x	
Anthocharis sara sara Lucas	x						
Euchloe ausonides Lucas	x	x					
Coenonympha "tullia" eryngii H.Edw.			x	x		x	x
Danaus plexippus L.					x	x	
Limenitis lorquini Edw.	x	x	x	x	x		
Adelpha bredowii californica Butl.					x	x	
Vanessa virginiensis Dru.		x	x		x	x	
Vanessa cardui L.			x	x	x		
Vanessa annabella Field		x		x		x	x
Precis coenia Hbn.					x	x	
Nymphalis californica Bdv.	x				x	x	
Nymphalis milberti furcillata Say				x		x	
Nymphalis antiopa L.	x	x				x	
Polygonia faunus rusticus Edw.						x	
Polygonia zephyrus Edw.	x			x		x	x
Phyciodes campestris Behr	x						
Phyciodes mylitta Edw.	x	x	x		x	x	x
Chlosyne hoffmanni segregata B. & McD.		x					
Euphydryas chalcedona nr. *wallacensis* Gund.	x						
Euphydryas editha nr. *edithana* Strand	x						
Boloria epithore Edw.	x	x	x	x			
Speyeria coronis Behr (*snyderi-simaethis* blend zone population)		x				x	
Speyeria zerene conchyliatus Comst.		x	x	x	x	x	x
Speyeria callippe nr. *rupestris* Behr		x	x				
Speyeria egleis nr. *oweni* Edw.	x	x	x	x	x	x	x
Speyeria atlantis Edw. (*dodgei*-melanic endemic)	x	x	x	x	x	x	x
Speyeria mormonia Bdv. ssp.						x	
Speyeria hydaspe purpurascens H.Edw.		x	x	x	x	x	
Satyrium saepium Bdv.				x			
Mitoura nelsoni Bdv.	x						
Mitoura spinetorum Hew.							x
Incisalia fotis nr. *mossii* H.Edw.	x						
Incisalia eryphon Bdv.	x	x					
Lycaena arota Bdv.						x	x
Lycaena heteronea gravenotata Klots				x	x		
Lycaena xanthoides Bdv. - *editha* Mead intergrades			x				
Lycaena gorgon Bdv.			x				
Lycaena hellodies Bdv.	x			x	x	x	x
Lycaena nivalis Bdv. ssp.		x	x	x	x		x
Plebeius "idas" ricei Cross-*anna* Edw. intergrades		x		x	x		
Plebeius saepiolus Bdv.	x	x	x	x			
Plebeius icarioides Bdv. ssp.	x	x		x			
Plebeius acmon Westw. & Hew.		x				x	x
Plebeius lupini Bdv.	x		x				
Agriades "glandon Prun." ssp.		x	x				
Everes amyntula Bdv.	x	x	x				
Glaucopsyche piasus Bdv.	x						
Glaucopsyche lygdamus nr. *columbia* Skin.		x	x				

Table 1 continued.

	vi.12.85	vii.3.85	vii.15.83	viii.10.83	viii.10.85	ix.5.85	ix.7.83
Celastrina argiolus echo Edw.	x						
Ochlodes sylvanoides Bdv.			x	x	x	x	x
Polites sonora Scud.	x	x	x	x			
Hesperia "comma complex"				x	x	x	
Hesperia juba Scud.	x					x	x
Pyrgus ruralis Bdv.	x						
Pyrgus communis Grote						x	
Erynnis icelus Scud. & Burg.	x						
Erynnis propertius Scud. & Burg.	x	x	x	x		x	
Total species recorded[1]	36	32	26	25	25	32	17

[1]Not counting *Colias* hybrids as a species.

diversity seen is at Little Shasta Meadow, which has a great variety of Composites and other showy flowering species. It has a light, sandy soil and supports many of the species also found at the summit in the subalpine forest. There are no true bogs, but the wetter meadows are filled with sedge peat. California pitcher plant *(Darlingtonia californica* Torr.), which is characteristic of boggy meadows in the ultrabasic Trinities and Eddies, is absent. Because the meadows are grazed seasonally by livestock, some herbaceous species may have been lost. Most of the meadows do not display severe sequelae of overgrazing, however.

Important nectar sources for collecting occur primarily along the roads and on the meadows. They are very spotty, resulting in high concentrations of butterflies in very small areas. On 5 September 1985, for example, over 30 species (several hundred individuals) were seen in a walk from Martin Dairy Campground to Kuck's Cabin, but it was common to see nothing but *Speyeria zerene* in 1-km stretches where no flowers were available. Among the most important nectar sources are *Monardella odoratissima, Haplopappus bloomeri, Eriogonum* spp., *Cirsium vulgare* (Savi)Ten., *Aster* spp., and *Chrysothamnus* spp.

FAUNISTICS AND PHENOLOGY

Table 1 presents a complete itemization of species seen on each of the three days in 1983 and four in 1985, when the mountain was collected thoroughly. Spring was late and cold in 1983, with very heavy and persistent snow pack. Spring was very early, warm, and dry in 1985, with snow completely gone by early June. The early summer was hot and dry and the late summer and autumn cold and wet, culminating in heavy snow to the 1,500 m level on 8 September. The two years of study thus embrace very different conditions and probably reflect accurately the amount of phenological variation to be expected in the Ball Mountain fauna. Most of the fauna is univoltine. The only species definitely having at least two broods are *Pontia occidentalis, Phyciodes mylitta,* and *Lycaena helloides* among residents and *Pieris rapae, Pontia beckerii, Colias eurytheme* and *philodice, Coenonympha "tullia" eryngii,* and *Plebeius acmon* among species whose ability to overwinter on Ball Mountain is strongly in doubt. A single late individual of *Papilio zelicaon* has been taken that might represent a rudimentary second brood (there is a late season flight at low elevations, and this is a hilltopping species). The single record of *Pyrgus communis* may also represent a fly-up.

Most of the summer univoltines have very long flights, those of most *Speyeria* including nearly the entire season. In *S. coronis*, males and females emerge early and mate; males then apparently die, but females disappear for several weeks in estivation then reappear; they may be common on yellow Composites in September. The hibernating Nymphalines (genera *Nymphalis, Polygonia,* and *Vanessa*) fly in both spring and autumn. Of them, only *V. annabella* may be partially double-brooded on the mountain. *Hesperia juba* has the same phenology as the Nymphalines and is suspected of hibernating as an adult also (Shapiro 1979). The meadow flora and fauna peak early, with many species disappearing by mid-Au-

gust. On Little Shasta Meadow the only plants in flower by early September are *Polygonum douglasii* var. *austinae* Jones and a few Asters. The overall butterfly phenology is unusual, with little change in the number of species over the entire season but peaks at both ends and a trough in mid-summer. This pattern, albeit weak, is nearly the inverse of the montane pattern shown in the Sierra Nevada (cf Donner Pass, Shapiro 1975: 189).

Comments follow on the most unusual elements in the fauna. Systematic order in Table 1 and the text follows Dornfeld, 1980, the geographically closest faunistic treatment in the literature.

***Pieris napi* L.** ssp.—One fresh male collected vi.12.85 at the edge of Little Shasta Meadow. It is very heavily marked and resembles first-brood *marginalis* Scud. from the north coast. There is an endemic "*napi*" in the Warner Mountains that has a similar first brood and a lightly marked "*pallidissima*" B. & McD. second brood and occurs on boggy meadows. The affinities of this isolated *napi* population need to be clarified, because the biogeography of the complex is very difficult in northern California (Geiger and Shapiro 1986a, in press).

***Colias*.**—Agricultural, alfalfa-based populations as high as the end of York Road are hybrid swarms involving *C. eurytheme* Bdv. and *C. philodice eriphyle* Edw. Both species and hybrids are common on all the meadows and even to the summit most of the season. There is definitely breeding on *Trifolium* spp., but the phenotypes of spring animals suggest colonization from below each year, rather than overwintering in situ. By September nearly all the clover on Little Shasta Meadow is senescent.

***Anthocharis sara sara* Lucas.**—Frequent along roadsides near Little Shasta Meadow. These butterflies have pure white ground color and are indistinguishable from montane *sara* from the Trinity Alps; they are extremely distinct from both yellow Sierran *stella* Edwards and from the yellow-tinged race from the Warners, and genetically they are identical to Trinity and North Coast Range *sara* (Geiger and Shapiro 1986b, in press).

***Euchloe ausonides* Lucas.**—These dense, montane-meadow populations behave as described by Dornfeld (p. 51) for Oregon ones, flying low above sedges and forbs in the wettest parts of the meadows. This is quite unlike the usual behavior of the species in other parts of California.

***Phyciodes campestris* Behr.**—These are quite normal *campestris*, with no tendency to reduction of the pattern as in Sierran *montana* Behr. They thus resemble Trinity-Eddy specimens.

***Euphydryas*.**—Only one specimen of each species has been taken, so that subspecific assignments in both cases are very tentative and largely based on Dornfeld's application of the names. The true identity of *edithana* Strand remains uncertain. Both subspecific assignments suggest affinity with the Warners.

***Speyeri coronis* Behr.**—These are typical "blend zone" populations like those found in the Eddies, Scott Mountains, and Scott Valley as well as in much of southern Oregon.

***Speyeria callippe* Bdv.**—This is a scarce species on Ball Mountain, and the subspecific assignment is based on a short series and must be considered tentative. All our specimens are silvered, and on average they fall between *rupestris* Behr and topotypical *juba* Bdv. in facies.

***Speyeria atlantis* Edw.**—Common to abundant, flying all season. There is a remarkable, apparently endemic melanic form in both sexes—more extreme in the female—with a frequency of over 50% above the junction of roads 47N03 and 46N10, and over 70% at the summit. This form (Fig. 3a) intergrades to more or less normal *dodgei* Gunder. One specimen taken ix.5.85 has one hindwing aberrant (Fig. 3d).

***Speyeria mormonia* Bdv.** ssp.—Outside the Sierra Nevada, this species was previously known in California only from Deadfall Lakes and Mount Eddy (Shapiro, Palm, and Wcislo 1981) and from the Warners. The subspecific identities of these populations are not clear; Shapiro et al. treated the Deadfall-Eddy population as an outlier of the Oregon Cascade *erinna* Edw., but neither it nor the somewhat paler Warner phenotypes precisely matches either Cascadian or Sierran material. Three specimens were collected ix.5.85 on flowers of *Haplopappus bloomeri* about 0.8 km below Little Shasta Meadow and on the lower portion of the meadow itself. They were among

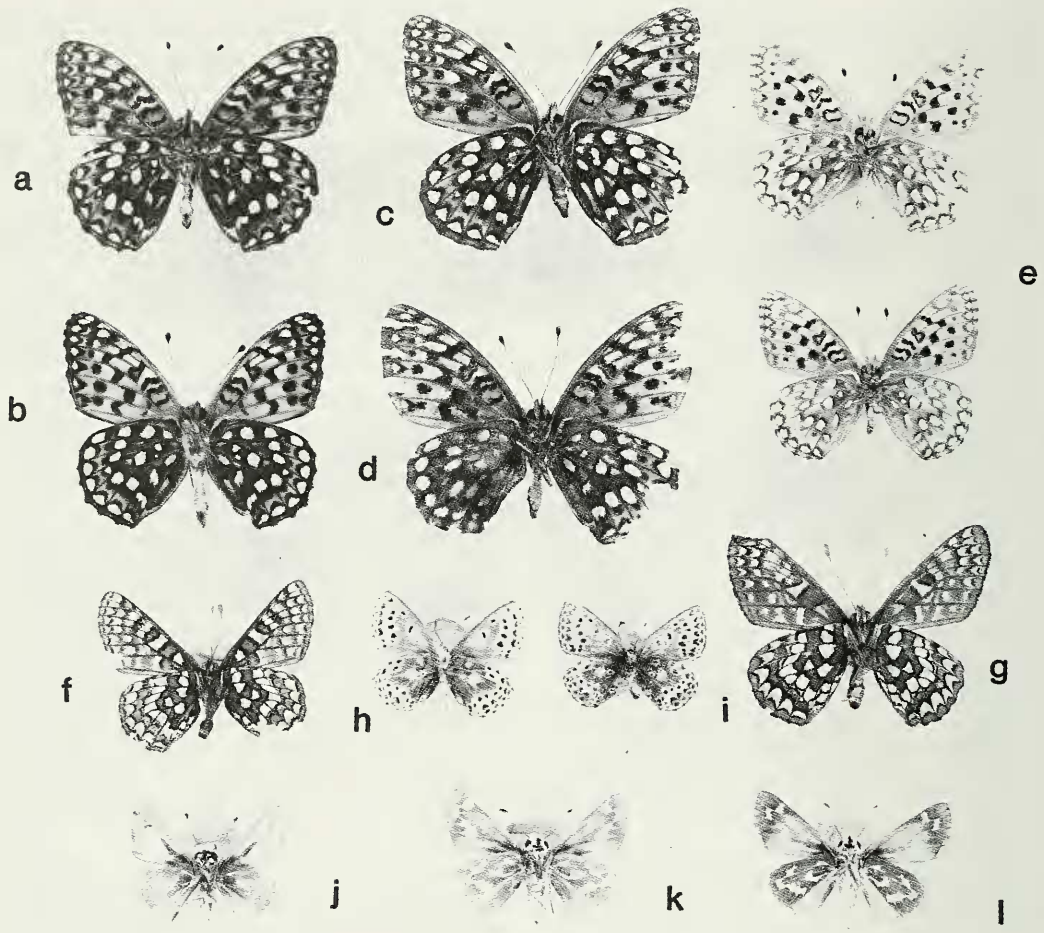

Fig. 3. Same as for Figure 2, ventral surfaces.

many other fritillaries of three species. All are very small (LFW 20-21.5 mm) and not a precise match for either Deadfall-Eddy or Warner specimens. Typical *mormonia* habitat (wet meadow) is abundant on Ball Mountain, but as in the Eddies the species appears to be rare and to emerge remarkably late in the season. The geography of *Speyeria mormonia* in far northern California promises to shed light on the history of biotic migrations in the Quaternary.

Lycaena heteronea gravenotata **Klots.**— The status of this subspecies name is controversial. Ferris and Brown (1981) gloss over any pattern of geographic distribution for spotted and unspotted hindwings in the Rocky Mountains. Dornfeld (1980) finds a definite pattern of spotted colonies within a region of generally unspotted ones. In California, the spotted morph is known *only* from Ball Mountain (Little Shasta Meadow to summit), nearby Goosenest, Warner Valley (just S. Mt. Lassen), and near Castella (J. F. Emmel, personal communication). These appear to be pure spotted populations, surrounded by pure unspotted ones. The host plant on Ball Mountain has not been determined, but a white-flowered *Eriogonum* that occurs at both Little Shasta Meadow and near the fire tower is suspected. (A member of the "*E. nudum* complex" is reportedly used at Warner Valley; J. F. Emmel, personal communication). There is no adult association with *E. umbellatum*, such as one sees consistently in the Trinities. Figures 4a,b and 5a,b show both sexes. Collectors should be aware of the possibility that further colonies exist near Mount Shasta. The possibility of sibling species cannot be discounted.

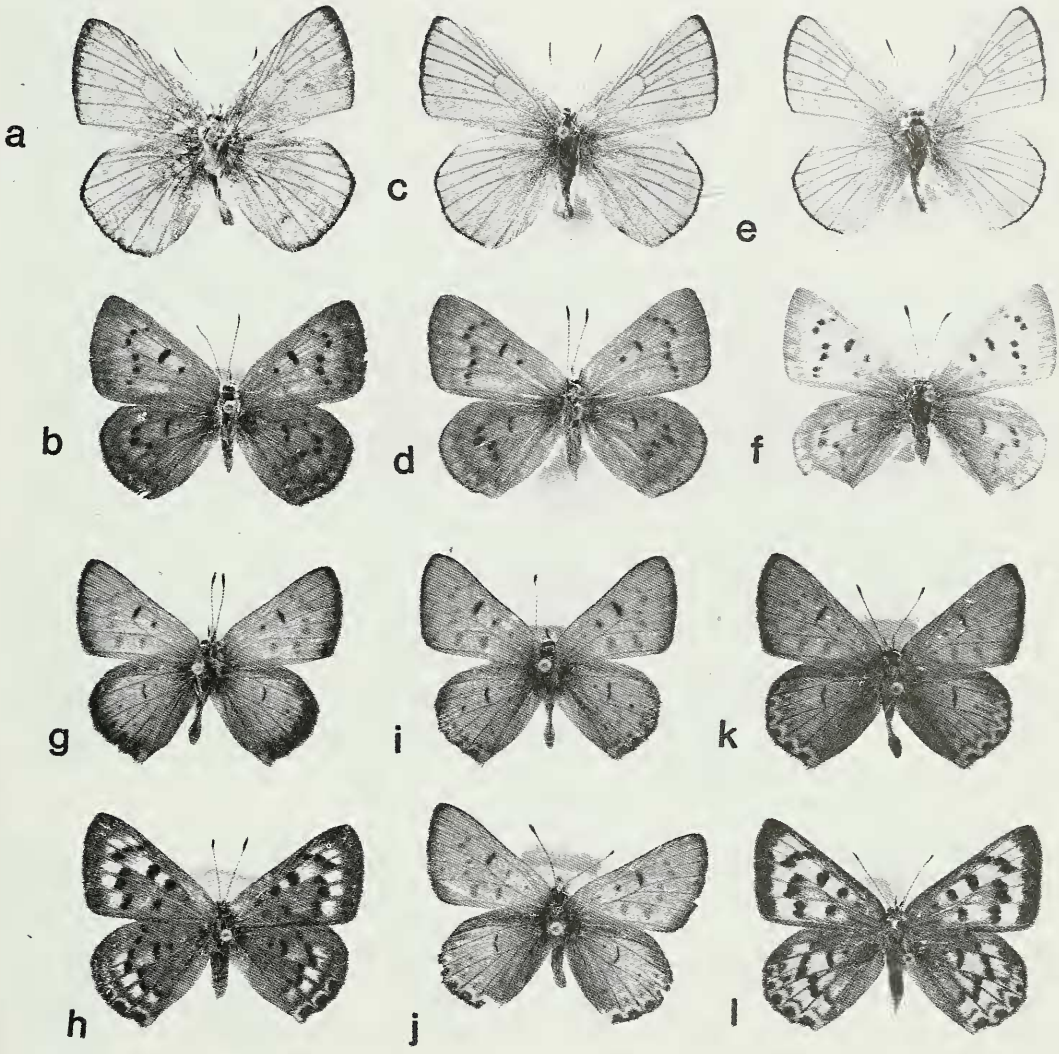

Fig. 4. Northern California *Lycaena*, dorsal surfaces: a, *L. heteronea gravenotata*, male, Ball Mountain, viii.10.83; b, same, female, Ball Mountain, viii.10.85; c, *L. h. heteronea* (?), male, Dry Lake Lookout, Siskiyou Co., viii.9.83; d, same, female, Dry Lake Lookout, viii.9.83; e, *L. h. heteronea*, male, Winnemucca Lake, Alpine Co., viii.24.83; f, same, female, Winnemucca Lake, viii.24.83; g. *Lycaena nivalis*, male, Ball Mountain, vii.15.83; h, same, female, Ball Mountain, vii.15.83; i, *L. nivalis*, Cedar Pass, Modoc Co., vi.9.85; j, *L. nivalis*, male, Winnemucca Lake, Alpine Co., viii.24.83; k, *L. nivalis* "form 1," male, Paradise Lake, Marble Mts., Siskiyou Co., vii.4.81; l, same, female, Paradise Lake, vii.4.81.

***Lycaena xanthoides* Bdv.-*L. editha* Mead.**—*Lycaena xanthoides* is found in the Central Valley (usually near the Sacramento River), in the San Francisco Bay area, the Transverse Ranges and some areas of southern California, and apparently disjunctly as a series of montane populations from Lake County through the Mendocino Pass–Anthony Peak area, and in the Willamette Valley in Oregon. *Lycaena editha* is found in the Rockies, the Sierra Nevada, and the Cascades as a montane-to-subalpine species. From Dunsmuir to Siskiyou Summit and from Gazelle to Ball Mountain and Iron Gate Reservoir occur a series of apparently intermediate populations, generally in agriculturalized valleys. The highest elevation of these is the one on road 47N03 near Kuck's Cabin, of which strays occur as high as Little Shasta Meadow. It also seems to be the easternmost of the blend-zone populations.

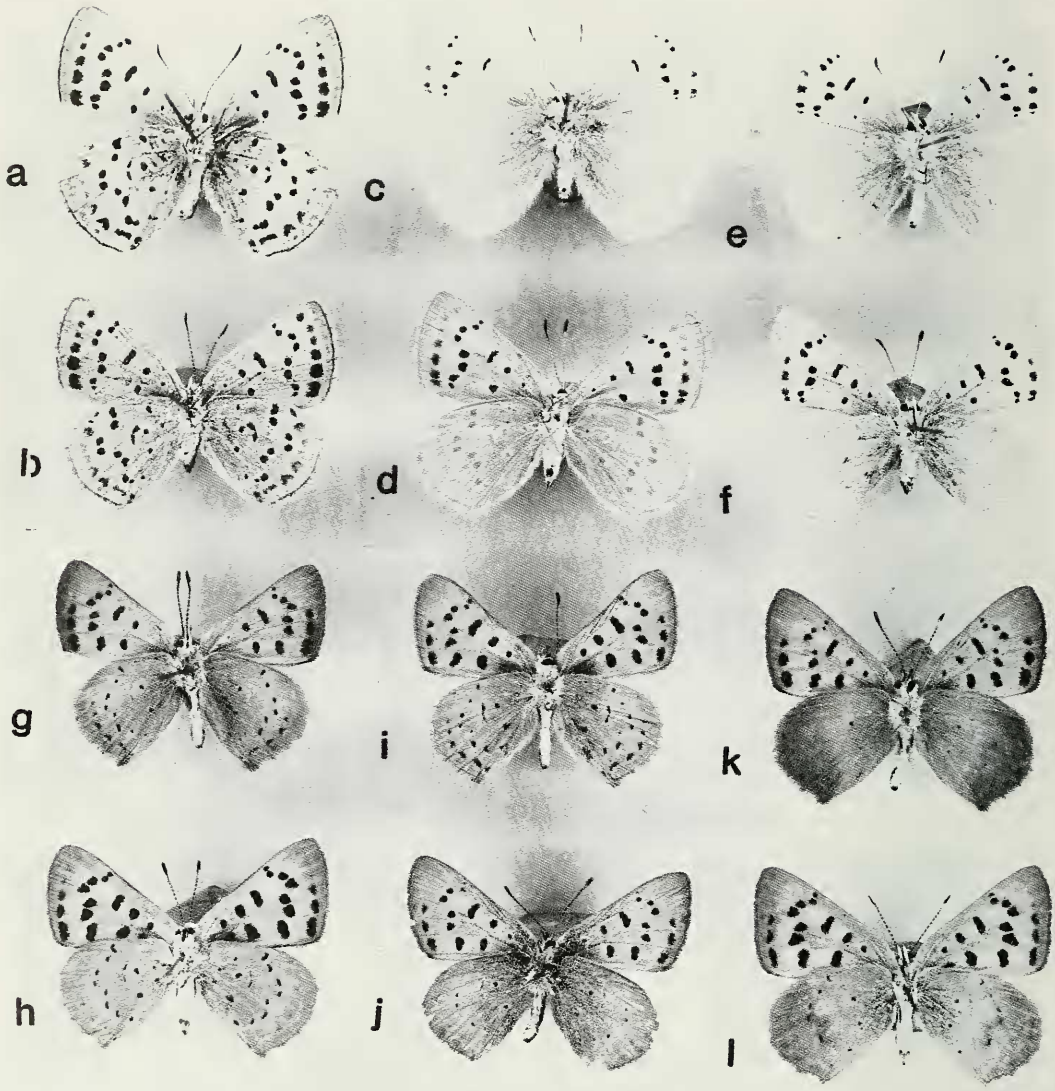

Fig. 5. Same as for Fig. 4, ventral surfaces.

Lycaena helloides Bdv.—This is usually considered a weedy lowland species, but here as elsewhere in northern California it seems to have permanent montane-meadow populations and has been seen laying on *Polygonum douglasii* var. *austinae* in September.

Lycaena nivalis Bdv.—Dornfeld (1980: 97, maps 137–138) pointed out that two "forms" of the nominal species *L. nivalis* occur in Oregon—sometimes sympatrically, sometimes not. Both also occur in northern California. Trinity-Eddy populations (Shapiro, Palm, and Weislo 1981) are 100% "form 1" (two-toned VHW), and Ball Mountain ones are 100% "form 2" (nearly unicolorous VHW). Form 1 has not been found east of U.S. Highway 5 in California to my knowledge. Form 2 is similar, but not identical, to the form that occurs in the Sierra Nevada. Some individuals show a tendency toward the endemic, heavily spotted Warner Mountains form. All these phenotypes are shown in figures 4g-l, 5g-l. At Little Shasta Meadow eggs are laid on *Polygonum douglasii* var. *austinae*. Trinity-Eddy form 1 use *P. spergulariaforme* Meissn., a closely related species. As with *L. heteronea*, sibling species are strongly suspected.

Agriades "glandon Prun." ssp.—Conspecificity with the European taxa of this

group is questionable. As noted by Shapiro, Palm, and Wcislo (1981), northern California populations are considerably darker and more heavily spotted beneath than Sierran *podarce* Felder (the usual usage, the type locality being simply "California"). The type of Boisduval's *nestos*, from Oregon, should be examined to determine its consubspecificity with these populations. Ball Mountain "*glandon*" average darker and more heavily spotted beneath than any other North American population known to me and seem to represent the extreme end of a cline (Figs. 2,3h,i).

***Hesperia* "*comma* complex."**—Again, the use of the name *comma* L. seems questionable. On the other hand, it is unclear what strictly Nearctic names apply to our handful of Ball Mountain specimens, which vary in complex ways between the taxa *oregonia* Edwards and *harpalus* Edwards; there is too little material (mostly from thistles along the roads, where *Hesperia* is enormously outnumbered by *Ochlodes sylvanoides* Bdv.) to say whether the phenotypes are altitudinally stratified as in the Trinities, or scrambled as on Mount Eddy. The range of variation is shown in figures 2, 3j-l.

DISCUSSION

This fauna of 68 species is remarkably rich for a forested, isolated mountain area that is surrounded by unforested lowlands. The major elements of biogeographic interest are enumerated below.

1. *Endemics*.—These include the melanic forms of *Agriades "glandon"* and *Speyeria atlantis*, and probably *Speyeria mormonia; Lycaena heteronea gravenotata* is a near-endemic (actually, most of the *Speyeria* species on Ball Mountain show local peculiarities, which, however, are less conspicuous than the melanism of *S. atlantis*).

2. *Regional Rarities*.—Species rare and local in northern California that occur in the study area include *Incisalia fotis*, *Mitoura spinetorum*, *Lycaena arota*, and *Erynnis icelus* (*L. arota* is relatively common in the Trinities but flies quite late, as here; it seems rare elsewhere in the region). *Polygonia faunus rusticus* is rare throughout its range; *Glaucopsyche piasus* nearly so.

3. *Intermediate or Transitional Populations*.—*Lycaena xanthoides–editha; Hesperia "comma* complex"; *Colias* hybrid swarms (common in agricultural alfalfa but not otherwise recorded in montane meadows regionally).

4. *Regionally Common Species, Rare on Ball Mountain*.—These include *Neophasia menapia*, *Phyciodes campestris*, *Chlosyne hoffmanni*, *Satyrium saepium*, *Plebeius "idas," Everes amyntula*, *Glaucopsyche lygdamus*, the *Hesperia "comma* complex," and *Pyrgus communis*.

5. *Range Extensions with Westward Affinities*.—*Anthocharis sara*.

6. *Range Extensions with Eastward (Warner Mountains) Affinities*.—Possibly both *Euphydryas*; possibly *Lycaena nivalis*.

7. *Absences*. These deserve special enumeration; they are species that, on a regional basis, would be considered likely on Ball Mountain but have not been found.

7a. *Alpine and Barren-Ground Species*.—Suitable habitats are clearly not present for *Papilio indra* Reak., *Parnassius phoebus sternitzkyi* McD., *Pontia sisymbrii* Bdv., and *Euchloe hyantis* Edw. *Callophrys lemberti* Tilden and *Philotes battoides* Behr may also fit in this category, though potential host plants are present.

7b. *Species of Special Habitats Apparently Absent or Too Isolated*.—*Lycaena mariposa* Reak. is common at the edges of boggy meadows in the Lodgepole Pine zone farther west (Trinities and Eddies, Scott Mountains). Perhaps the meadows on Ball Mountain are insufficiently boggy. The host plant remains unpublished but is reported to be *Vaccinium* spp. (G. Pratt, in litt.) This plant is not recorded on Ball Mountain. *Euphyes vestris* Bdv. has been found in several isolated boggy meadows (e.g., Scott Mountain Summit Bog). Its host plant, *Cyperus*, occurs near Little Shasta Meadow, but the colony is perhaps too small and isolated to support the skipper.

7c. *No Apparent Explanation*.—These include *Chlosyne palla* Bdv., *Satyrium fuliginosum* Edw., *S. sylvinus* Bdv., *S. californica* Edw., *Incisalia iroides* Bdv., *Philotes enoptes* Bdv., *Thorybes mexicana nevada* Scud./*aemilia* Skin., and *Polites sabuleti* Bdv. Several of these are regionally rare or local (*fuliginosum, sylvinus, californica, iroides*). But *Polites sabuleti* is the single most common butterfly in the Trinities and Eddies (Shapiro,

TABLE 2. Composition by family of some regional butterfly faunas.

Family	Trinity Alps[a]	Mt. Eddy[a]	Crater Lake[b]	Ball Mountain
Papilionidae	7	5	4	4
Pieridae	14	7	9	9
Satyridae	4	3	4	1[c]
Danaidae	1	1	1	1
Nymphalidae	31	25	25	24
Riodinidae	1	1	0	0
Lycaenidae	32	27	26	21
Hesperiidae	25	11	11	8
Totals	115	80	80	68

[a]Shapiro, Palm & Weislo 1981.
[b]Tilden & Huntzinger 1978.
[c]*Oeneis nevadensis* may also occur.

Palm, and Weislo 1981). It occurs on the N slope of Mt. Shasta and, at low density, in the agricultural lands both east and west of Ball Mountian; there appears to be no population adapted to montane meadows in the Little Shasta Country. This is not surprising in one sense: there is no place known where both *Ochlodes sylvanoides* and *Polites sabuleti* are common in northern California; their abundances tend to be inversely correlated, and *sylvanoides* is the commonest skipper on Ball Mountain.

7d. *Biennials.—Oeneis nevadensis* Feld. & Feld. has a two-year life cycle in much of its range, flying only in even-numbered years. Thus, if it occurs (in the lower montane coniferous forest) on Ball Mountain it would have been missed by sampling in 1983 and 1985. It is the only known biennial butterfly in the region.

A final question is that of the faunal balance. As revealed in Table 2, the family breakdown of the Ball Mountain fauna is basically consistent with other regional faunas, though slightly impoverished in Hesperiidae. What does not emerge from these data is the enormous biomass of the genus *Speyeria*, whose members are overwhelmingly dominant over virtually all habitats on Ball Mountain. This is not the only such place in northern California: Anthony Peak (Mendocino County), for example, is another. But even the casual visitor cannot help but notice how all other butterflies appear rare in comparison to the large fritillaries. Since all of them presumably feed on the genus *Viola*, which is neither unusually conspicuous nor unusually diverse on Ball Mountain, their abundance poses an ongoing ecological problem.

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LITERATURE CITED

DORNFELD, E. J. 1980. The butterflies of Oregon. Timber Press, Forest Grove, Oregon. 276 pp.

FERRIS, C. D., AND F. M. BROWN. 1981. Butterflies of the Rocky Mountain States. University of Oklahoma Press, Norman. 442 pp.

GEIGER, H. J., AND A. M. SHAPIRO. In press. Electrophoretic evidence for taxonomic relationships within the western North American "*Pieris napi*". J. Res. Lepid.

———. In press. Electrophoretic evidence for speciation within the nominal species *Anthocharis sara* (Pieridae). J. Res. Lepid.

RUNDEL, P. W., D. J. PARSONS, AND D. T. GORDON. 1977. Montane and subalpine vegetation of the Sierra Nevada and Cascade ranges. Pages 559–600 *in* M. G. Barbour and J. Major, eds., Terrestrial vegetation of California. John Wiley, New York. 1,002 pp.

SHAPIRO, A. M. 1975. The temporal component of butterfly species diversity. Pages 181–195 *in* M. L. Cody and J. M. Diamond, eds., Ecology and evolution of communities. Belknap Press, Harvard, Cambridge, Massachusetts. 545 pp.

———. 1979. Does *Hesperia juba* (Hesperiidae) hibernate as an adult? J. Lepid. Soc. 33: 258–260.

SHAPIRO, A. M., C. A. PALM AND K. L. WCISLO. 1981. The ecology and biogeography of the butterflies of the Trinity Alps and Mount Eddy, northern California. J. Res. Lepid. 18: 68–152.

TILDEN, J. W., AND D. H. HUNTZINGER. 1978. The butterflies of Crater Lake National Park, Oregon. J. Res. Lepid. 16: 176–192.

WILLIAMS, F. X. 1909. The butterflies and some of the moths of the Mount Shasta region. Ent. News 20: 62–75.